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(72) Inventor RALPH ALAN NIXON

(19)

(54) IMPROVEMENTS IN OR RELATING TO ANCHORING DEVICES

(71) I, SECRETARY OF STATE FOR INDUSTRY, of London, do hereby declare the invention, for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to improvements in underwater anchoring devices and in particular to anchoring devices which provide an achorage by embedding themselves into the water bed.

Currently known anchoring devices include anchors, piles and gravity-dependent systems. The most common method of anchoring, ie using a conventional anchor, suffers from the inherent disadvantage that the final siting of the anchor is uncertain since it has to be dragged an indeterminate distance before developing its full holding power. Its resistance to pullout load/self-weight is also relatively low and undesirable lengths of mooring chain are required to provide the necessary near-horizontal pull against the anchor. Piling is expensive and restricted for practical reasons to relatively small depths of burial and gravity-dependent systems are practicable only in soft mud and where the control of sinking is unimportant.

A known variation on the gravity-dependent anchoring devices is the use of high pressure fluidising jets located adjacent the underside of the anchoring device and operative to fluidise the seabed material such that the anchoring device will then sink under its own weight. This method of anchoring however is limited to use in non-cohesive granular type seabeds such as sand or gravel since soft clays and muds cannot readily be fluidised by jetting action.

The object of the present invention is to provide an anchoring device capable of handling and functioning efficiently in bed materials comprising gravel, sand, mud and soft clay.

According to the present invention a device for providing an anchorage in the bed of a volume of water comprises a body member, at least one suction passageway extending at least part way through the body member and fluidising water outlet means located in the general area beneath the lower open end of the suction passageway and positioned relative to the lower open end of the suction passageway such that in use, and with suction applied to the suction passageway and fluidising water made available through the fluidising water outlet means, sufficient water is present in the region of the lower open end of the suction passageway to enable the bed material immediately below the body member to be transferred, through the suction passageway as solids in suspension in water, from below the body member whereby the body member will bury and continue to bury itself deeper into the water bed material.

In another aspect of the invention a device for providing an anchorage in the bed of a volume of water comprises a body member including a conical portion, a suction passageway extending at least part way through the body member and through the apex of the conical portion and fluidising water outlet means located in the region of the base of the conical portion.

In most applications the anchoring device would preferably include a single suction passageway located in the central region of the body member although larger anchoring devices might include the provision of several suction passageways each extending from above the body member to the open area beneath the body member.

In a first embodiment of the invention for use particularly with free running solids such as for example sand and gravel, the conical portion may be in an inverted state with its apex extending downwardly towards the lower open end of the suction passageway and the body member advantageously

may be provided with a peripheral skirt portion extending substantially vertically downwardly to shield the fluidising water outlet means and to contain the volume of bed material drawn up through the suction passageway to that immediately below the body member.

In this first embodiment the fluidising water outlet means may include a number of individual passageways extending from a lower position in the region adjacent the lower open end of the suction passageway to an upper position in the free water above the water bed whereby in use free water is always made available in the region of the lower open end of the suction passageway.

Alternatively the fluidising water outlet means may include a generally annular passageway in the peripheral base region of the conical portion, the annular passageway being fed in use with free water from above the water bed and there being provided in the boundary wall of the annular passageway a series of apertures through which the free water can be directed into the general region of the lower open end of the suction pasageway.

The means for providing suction in the suction passageway to induce solids in suspension in water to pass through the passageway may conveniently be an annular jet pump fed by a supply of water under pressure. The annular stream of water is directed up the suction passageway and this action induces a core of solids/water to be drawn up from the water bed. Opposite the upper open end of the suction passageway there may be positioned an umbrella-like deflector which in use deflects the induced solids/water mixture drawn up from below the body member such that it settles over the body member.

Preferably the included angle at the apex of the conical portion is less than the included angle of the naturally formed conical depression formed in the water bed material when the water bed material is drawn up through the apex of the conical portion. Also in the preferred arrangement the lower open end of the suction passageway extends down below the lower region of the skirt portion to an extent whereby the angle of an imaginary line joining the lower region of the skirt portion to the lower open end of the suction passageway is less than the natural angle of repose of the water bed material when considered relative to the horizontal plane.

In a preferred arrangement of the first embodiment of the invention a device for providing an anchorage in the bed of a volume of water includes a body member comprising essentially an open ended cylindrical skirt portion, a conical portion mounted coaxially within the skirt portion and with the apex region of the conical portion extending below the open end of the skirt portion, a suction passageway located along the axis of the skirt and conical portions and extending through the apex region of the conical portion, and fluidising water passageways arranged circumferentially around the suction passageway and having their lower ends extending through the wall of the conical portion into the space provided between the skirt and the conical portions whereby in use and with suction applied to the suction passageway a mixture of bed material/water from immediately below and within the skirt portion is drawn up the suction passageway and discharged over and above the anchoring device, necessary fluidising water for the efficient continued operation of the device being provided to the bed material via the fluidising water passageways.

In an anchoring device of the invention for use in a variety of bed materials including those containing soft clays and muds the fluidising water outlet means are located in the general area beneath the lower open end of the suction passageway and in a second embodiment of the invention include a toroidal ring located around the base of the conical portion and having a series of apertures in the inner circumferential region through which fluidising water can be directed into the general region of the lower open end of the suction passageway. Preferably the apertures are arranged to direct jets of fluidising water radially of the toroidal ring and also in a downwardly direction to form a cylindrical or conical form curtain of jetting water.

In an alternative arrangement of the second embodiment of the invention the fluidising water outlet means includes a generally annular passageway in the peripheral base region of the body member, the annular passageway being fed in use with water under pressure and there being provided in the boundary wall of the annular passageway a series of apertures through which the water under pressure can be directed into the general region below the lower open end of the suction passageway.

The means for providing suction in the suction passageway to induce solids in suspension in water to pass through the passageway may conveniently be an air-lift pump operative by introducing air under pressure into the suction passageway just above its lower open end.

Means for releasing the anchoring device from a position within the water bed material may conveniently be the controlled release of water under pressure in the region immediately above the body member

bodiment of Figures 5 or 6 could take,

Figure 8 illustrates a vertical section through a typical anchoring device in accordance with a third main embodiment of the invention and utilising fluidising water supplied under pressure,

Figure 9 is a view on the section IX-IX of Figure 8, and

Figure 10 is a schematic representation of an anchoring device of the second or third main embodiments of the invention (Figures 5, 6 and 7 or 8 and 9) embedded in a water bed material.

The basic principle upon which the invention is based is that the water bed material into which the anchoring device is to be sunk is transferred through a centrally located suction passageway from immediately beneath the anchoring device to a point above the anchoring device such that the anchoring device progressively buries itself into the water bed.

Referring initially to Figures 1 and 2 the anchoring device of the first main embodiment of the invention has a body portion 10, a skirt portion 11 and extending vertically through the centre of the anchoring device a suction passageway 12. A conical portion 13 depends within the skirt portion 11 and fluidising water passageways 14 are located circumferentially around the suction passageway 12 and extend from a lower position in the space between the conical portion 13 and skirt portion 11 upwardly to an upper portion located in the free water above the water bed.

A solids-handling annular jet pump 15 fed by a water supply (not shown) operates to induce a mixture of water bed material and water up the suction passageway 12 to a point where it impinges upon an umbrella-like deflector 16 which deflects the mixture down and over the anchoring device.

Considering now Figure 3 the geometry of the underside of the anchoring device of Figures 1 and 2 is illustrated relative to the natural angle of repose of the water bed material. It is well known in suction dredging that a suction applied to a relatively free-running bed material results in a conical depression being formed in the bed material. The angle of slope of the conical depression relative to the horizontal plane is defined as being the angle of repose of the bed material. If this angle is designated as z the cone half angle of the depression will be 90° minus z and the included angle of the depression will be 2 (90° minus z). For the said angle of repose, z is of the order of 30°.

It is therefore possible to bury an inverted conical shape into a bed material by suction pumping the bed material out through a hole in the apex of the conical body provided the included angle of the conical body is less than 2 (90° minus z).

One of the main objects of the anchoring device of the present invention is that it can bury itself in the bed material with minimum disturbance to the bed material immediately surrounding it. In order to prevent the excavated hole from spreading beyond the base diameter of the inverted conical portion 13 it is necessary to provide the skirt portion 11 which will entrain the surrounding bed material by progressive scour. The depth of the skirt portion 11 relative to the conical portion 13 is also dicated by the angle of repose, z of the water bed material. Using the diagram of Figure 3 ie assuming that the skirt portion 11 depends from the base of the conical portion 13, and taking the base diameter of the conical portion 13 as being D and its height as being H, the skirt portion 11 must be deeper than H minus $D/2 \tan z$.

With this particular geometry it will be seen that there is always provided a space between the conical portion 13 and the water bed material into which fluidising water can be admitted to aid scouring of the water bed material. Additionally the skirt portion 11 will always be embedded into the bed material such that the natural scouring action is restricted to within the diameter of the skirt portion 11 with the result that the surrounding bed material is left unaffected.

Referring now to Figure 4 a cylindrical member 40 is positioned within the base region of the conical portion 13 to provide an annular space 41 between the sloping sides and the base of the conical portion 13. Apertures 42 are provided in the sloping side of the conical portion 13 to provide a fluid communication between the annular space 41 and the space contained between the conical portion 13 and the skirt portion 11.

With this particular arrangement fluidising water may be made available in the region of the base between the skirt portion 11 and conical portion 13 without the need for individual fluidising water passageways (compare fluidising water passageways 14 of Figure 1). The annular space 41 need be fed with fluidising water from only a small number of fluidising water passageways 43.

The operation of the anchoring device described above with reference to Figures 1 to 4, is simple and straight forward. It is assumed that the nature of the water bed material into which the anchoring device is to bury itself is known and that the underside has been designed in accordance

with Figure 3 and also that the depth to which the anchoring device will bury itself is known such that the fluidising water passageways 14 are sufficiently long to remain in the free water above the water bed for the duration of the movement of the anchoring device. With these criteria met the supply of jet water to the jet pump 15 is switched on. The annular jet of water then passing up the upper regions of the suction passageway 12 induces a mixture of the water bed material and the water to be drawn up the centre of the suction passageway 12 to a point where it impinges upon and is deflected by the umbrella-like deflector 16. In this manner water bed material is transferred from immediately below the anchoring device to a position immediately above the anchoring device. As the depth of the anchoring device increases and the bed material becomes more densely packed ie there is a reduced volume of naturally available water, the suction induced at the open end of the suction passageway 12 also acts to draw fluidising water from above the liquid bed via the fluidising water passageways 14. This enables the anchoring device to bury itself still deeper in the bed material irrespective of the local environment which might otherwise be hostile to efficient suction dredging.

The exact amount of fluidising water made available at the head of the anchoring device is dependent upon for example the number of and diameter of the fluidising liquid passageways 14 or 43. In a particular anchoring device on which preliminary experiments have been conducted the outer diameter of the skirt portion 11 was 300 mm and its height was 120 mm, the conical portion 13 had an included angle of 90° and a height of 150 mm. The anchoring device also had eight equally pitched fluidising water passageway pipes 14 each of 20 mm bore and with a jet supply pressure of 300 kN/m^2 the anchoring device buried itself stably at a constant rate of approximately 5 mm per second. The particular design described provided potentially more than an adequate supply of fluidising water but this is a matter which would require to be optimised for the application in hand. It should be noted that an excess of fluidising water will not cause malfunction of the anchoring device but merely a decrease in its burial rate.

The anchoring device of the first main embodiment and described above with reference to Figures 1 to 4 has proved most successful in burying itself into sandy bed materials. Its efficiency however has been somewhat limited when used in mixed bed materials including sticky cohesive substances such as clays and muds.

For this reason there is now described the second main embodiment of the invention with reference particularly to Figures 5, 6 and 7.

Referring initially to Figure 5, the anchoring device of the second main embodiment comprises a main body member 10 of generally cylindrical form having an open based conical portion 51 in its lower region. A central suction passageway 12 extends through the body member 10 from the apex region of the conical portion 51. The included cone angle of the conical portion 51 is 90° although the angle is not critical.

An annular chamber 53 formed in the lower region of the body member 10 between its outside wall and the lower region of the conical portion 51, is arranged to contain fluidising water under pressure fed from a water source via a water inlet pipe 54. Two rows of fluidising jets (holes) 55 are provided through the inner circumferential boundary wall of the annular chamber 53, the upper row of jets 55 being arranged to direct a sheet of fluidising water in a substantially horizontal plane and the lower row of jets 55 being arranged to direct a curtain of fluidising water downwardly in a substantially vertical direction.

An air-lift pump is provided in the suction passageway 12 and comprises simply four equally spaced apertures 56 which in use are fed with compressed air via the air inlet pipe 57.

In operation the anchoring device is lowered through the water to rest on the bed material in which the anchorage is required. Fluidising water is supplied under pressure to the fluidising water chamber 53 and compressed air is similarly supplied via the apertures 56 to initiate operation of the air-lift pump. The fluidising water emitting through the fluidising jets 55 act on the bed material immediately beneath the body member 10 and in conjunction with suction from the air-lift pump cause the solid bed materials to be extracted through the suction passageway 12. As bed material is thus removed from beneath the body member 10 the weight of the anchoring device as a whole causes it to move down into the excavated area so burying itself. This progressive movement is maintained until the anchoring device has reached a desired depth in the bed material. It is essential of course that the upper end of the suction passageway 12 shall extend at least to the datum bed material level when the anchoring device is at its deepest point of travel so that the excavated bed material can be ejected into the free flowing water above the bed.

The arrangement of Figure 6 shows an alternative design of the anchoring device

of the second main embodiment of the invention in which the fluidising water is provided via a perforated toroidal ring 60 located around the inner peripheral base region of the conical portion 51. As with the arrangement of Figure 5 water under pressure is supplied to the toroidal ring 60 via a water inlet pipe 54. The toroidal ring 60 is provided with a series of water jet holes 65, one row being positioned in the plane of the ring 60 and operative to provide a series of radially directed jets of water and a further row of fluidising jets 65 each arranged normal to the plane of the ring 60 and operative to cause a substantially cylindrical curtain of water jets. Operation of the anchoring device is identical to that described relative to the design of Figure 5.

Referring now to Figure 7, there is shown schematically a form which a typical production anchoring device of the second main embodiment might take. The body member 10 and conical portion 51 are fabricated in for example, steel plate, the top of the body member 10 including a stressed platform member 70. The volume between the plate fabricated body member and the stressed platform 70 can conveniently be filled with any dense or relatively dense mixture of rubble and concrete 71. Normal plumbing (not shown) for the supply of fluidising water under pressure and also for the supply of compressed air to operate the air lift pump would be designed into the device before such a concrete mix were poured.

Above the anchoring device and attached to the stressed platform 70 would be webbed attachment members to which mooring cables etc could be attached.

Preliminary trials with anchoring devices made in accordance with Figures 5 and 6 have shown that they can sucessfully be buried into soft mud and other cohesive materials. In one trial for example an anchoring device of the type shown in Figure 6 was buried to a depth of 7 metres in about 40 minutes. The device was of 30 cm outside diameter and required a pull in excess of 6 tonnes to remove it.

Experimentation with the anchoring device of the second main embodiment led to a further main design within the principles of the invention and this is described now as the third main embodiment with reference particularly to Figures 8, and 9.

Referring firstly to Figure 8 the anchoring device of the third main embodiment comprises a main body member 10 having a flat circular top portion 80 and depending therefrom a cylindrical skirt member 81. The central suction passageway 12 extends from the space contained within the skirt member 81 upwardly through the flat top portion 80. An annular chamber 82 formed in the flat to portion 80 is arranged to contain fluidising water fed under pressure from a water source via a water inlet pipe 83.

A primary central fluidising nozzle 84 is positioned immediately beneath the central suction passageway 12 and fed by means of cranked feed pipes 85 connected at their reverse ends with the annular chamber 82. The fluidising nozzle 84 includes a vertically directed jet 87 and horizontally directed jets 88. Secondary fluidising jets 89 in the form of short cranked tubes are located circumferentially around the annular chamber 82 and are arranged such that in use they will diret fluidising water under pressure to the lower circumferential skirt periphery reggion of the body member 10.

An air-lift pump is provided in the central suction passageway 12 and comprises simply an air jet nozzle 90 which in use is fed with compressed air via an air inlet pipe 91.

Figure 9 is a view on the section IX-IX of Figure 8 and shows the disposition of the secondary fluidising jets 89.

Operation of the anchoring device as shown in Figures 8 and 9 is similar to that described relative to the anchoring device of the second main embodiment and described with reference to Figures 5, 6 and 7. The fluidising water fed via the secondary fluidising jets 89 acts to fluidise the bed material in the region immediately beneath the lower peripheral portion of the skirt member 81 thereby enabling it to settle down into the bed material whilst fluidising water fed through the central fluidising nozzle 84 fluidises the bed material in the central region immediately beneath the central suction passageway 12 enabling it to be excavated through the suction passageway 12 by means of the air-lift pump and ejected into the free flowing water above the bed.

One example of this design of anchoring device which has been successfully tested had an overall skirt 81 diameter of 61 cm, a flat top portion 80 thickness of about 7.5 cm, a depended skirt depth of about 18 cm and with the central fluidising nozzle 84 positioned about 20 cm beneath the lower peripheral portion of the skirt member 81. Twenty-four secondary fluidising jets 89 were provided equi-pitched around the circumferential region of the annular chamber 82.

Figure 10 shows an anchoring device 100 according to the second (Figures 5, 6 and 7) or the third (Figures 8 and 9) main embodiments of the invention buried in a water bed material 101. It will be noted that the suction passageway 12 extends into the free running water 102 above the bed material 101. Since the bed material 101 excavated from beneath the anchoring

device 100 during its descent into the bed material 101 is ejected into the free flowing water 102 and not immediately on top of the anchoring device 100 there is a natural tendency in the initial stages at least for the anchoring device 100 to simply create a hole in the bed material 101. In practice, however, the side walls of any hole which tends to form slowly collapse behind and above the anchoring device 100 to completely bury it. Normal settling and compaction of the bed material 101 above the anchoring device 100 is in time achieved by the natural action of tides etc.

It will be understood that the fluidising water might be supplied either from an independent pressure source or simply from the pressure reduction generated in the region of the inlet of the suction passageway when burying in deeper water.

In known techniques of pressure scouring to allow an anchoring device to settle into a water bed material the general principles are to fluidise the bed material such that the weight of the anchoring device causes it to settle whilst the bed material passes around and engulfs it much like in a quick sand. Such techniques are not fully controllable and when operating in layers of cohesive material the scouring jets tend to consolidate the cohesive bed material rather than to separate and fluidise it. In the anchoring devices of the first and second main embodiments of the invention the combined effect of the fluidising jets in the lower region of the anchoring device and the suction created by the air-lift pump directly above causes the cohesive bed material to separate and be extracted through the body of the anchoring device.

The anchoring devices in accordance with the present invention are more similar to pin piles than to conventional anchors and are capable of being driven into a variety of water bed materials. The anchoring devices develop a high resistance to pull out as well as lateral movement.

Although the anchoring devices of the invention are intended primarily as a means of providing a permanent anchorage, there may be provided in the region immediately above the anchoring device additional fluidising jet means whereby the bed material above the anchoring device may be fluidised to facilitate easy withdrawal.

The particular advantages of the anchoring devices of the invention are that relative to conventional anchors they have potentially a high holding power/weight ratio, bury themselves precisely at the point at which they are dropped and can accept a steep angle of pull. Relative to pile anchors they drive themself in independent of depth and relative to gravity systems they are of low weight.

The obvious limitations are that they will not work in very stiff clays or rock beds, may require an independent pumped water supply from the surface when used in shallow water and/or in strongly compacted sea bed material and must be laid from a stationary surface vessel.

The following examples are some of the many applications envisaged:—

Single anchoring devices for marker buoys and small vessels.

Multiple anchoring devices for single point moorings for large vessels.

Underpinning gravity based structures to provide lateral restraint.

Light piling applications (for example channel marker piles, underwater breakwaters, pipeline anchorage).

It will be readily appreciated by those skilled in the art that the variations on the general design of the anchoring devices of the present invention whilst retaining the broad principles of the invention are as numerous as the applications to which they might be put. In this respect the foregoing descrpition is in no way to be taken as having a limiting effect on the invention.

WHAT I CLAIM IS:—

1. A device for providing an anchorage in the bed of a volume of water including a body member, at least one suction passageway extending at least part way through the body member and fluidising water outlet means located in the general area beneath the lower open end of the suction passageway and positioned relative to the lower open end of the suction passageway such that in use, and with suction applied to the suction passageway and fluidising water made available through the fluidising water outlet means, sufficient water is present in the region of the lower open end of the suction passageway to enable the bed material immediately below the body member to be transferred, through the suction passageway as solids in suspension in water, from below the body member whereby the body member will bury and continue to bury itself deeper into the water bed material.

2. An anchoring device as claimed in Claim 1 in which there is provided a single suction passageway extending at least part way through the central region of the body member.

3. An anchoring device as claimed in Claim 1 or 2 in which the body member comprises essentially a platform portion and depending therefrom a cylindrical skirt portion, the suction passageway extending at least through the platform portion.

4. An anchoring device as claimed in Claim 1, 2 or 3 in which the fluidising water outlet means are located beneath the

body member and ahead of the lower open end of the suction passageway.

5. An anchoring device as claimed in Claim 4 in which the fluidising water outlet means is a single jet nozzle positioned coaxially with the suction passageway a short distance beneath the lower periphery of the skirt portion so as to be at the apex of an imaginary shallow cone formed with the lower periphery of the skirt portion as its base.

6. An anchoring device as claimed in Claim 5 in which the jet nozzle includes fluidising jets disposed to direct in use fluidising water in a substantially downwardly direction.

7. An anchoring device as claimed in Claim 3, 4, 5 or 6 in which the body member includes an annular chamber in or on its platform portion, the annular chamber being in fluid connection with the fluidising water outlet means.

8. An anchoring device as claimed in any one of the preceding Claims 3 to 7 in which there are provided secondary fluidising water outlet means located in the general region around the lower open end of the suction passageway.

9. An anchoring device as claimed in Claim 8 in which the secondary fluidising water outlet means comprise a series of individual jets located within the skirt portion and arranged in use to direct a curtain of fluidising water towards the lower peripheral region of the skirt portion.

10. An anchoring device for providing an anchorage in the bed of a volume of water comprising a body member including a conical portion, a suction passageway extending at least part way through the body member and through the apex of the conical portion and fluidising water outlet means located in the region of the base of the conical portion and positioned relative to the lower open end of the suction passageway such that in use, and with suction applied to the suction passageway and fluidising water made available through the fluidising water outlet means, sufficient water is present in the region of the lower open end of the suction passageway to enable the bed material immediately below the body member to be transferred, through the suction passageway as solids in suspension in water, from below the body member whereby the body member will bury and continue to bury itself deeper into the water bed material.

11. An anchoring device as claimed in Claim 1, 2 or 10 in which the fluidising water outlet means include a toroidal ring located around the base of the body member and having a series of apertures in the inner circumferential region through which in use fluidising water can be directed into the general region of the lower open end of the suction passageway.

12. An anchoring device as claimed in Claim 10 in which the conical portion is in an inverted state with its apex extending downwardly towards the lower open end of the suction passageway and with the body member including a peripheral skirt portion extending substantially vertically downwardly from the base region of the conical portion so as to shield the fluidising water outlet means and, in use, to contain the volume of bed material drawn up through the suction passageway to that immediately below the body member.

13. An anchoring device as claimed in Claim 10 or 12 in which the fluidising water outlet means include a number of individual passageways extending from a lower position in the region adjacent the lower open end of the suction passageway to an upper position in the free water above the water bed whereby in use free water is always made available in the region of the lower open end of the suction passageway.

14. An anchoring device as claimed in Claim 10 or 12 in which the fluidising water outlet means include a generally annular chamber in the peripheral base region of the conical portion the annular chamber being fed in use with free water from above the water bed and there being provided in the boundary wall of the annular chamber a series of apertures through which the free water can be directed into the general region of the lower open end of the suction passageway.

15. An anchoring device as claimed in any one of the preceding Claims 10, 12, 13 or 14 in which the means for providing suction in the suction passageway to induce solids in suspension in water to pass through the passageway is an annular jet pump fed in use by the supply of water under pressure.

16. An anchoring device as claimed in any one of the preceding Claims 10, 12 to 15 in which there is provided opposite the upper open end of the suction passageway an umbrella-like deflector which in use deflects the induced solids/water mixture drawn up from below the body member such that it settles over the body member.

17. An anchoring device as claimed in any one of the preceding Claims 1 to 11 in which the means for providing suction in the suction passageway to induce solids in suspension in water to pass through the passageway comprises an air-lift pump operative by introducing air under pressure into the suction passageway just above its lower open end.

18. An anchoring device as claimed in any one of the preceding claims in which there are provided means for releasing the anchoring device from a position within the

water bed material by the controlled release of water under pressure in the region immediately above the body member of the anchoring device.

19. An anchoring device substantially as hereinbefore described with reference to Figures 1, 2 and 3 or to Figure 4, or to Figures 5, 7 and 10 or to Figures 6, 7 and 10, or to Figures 6, 7 and 10, or to Figures 8, 9 and 10 of the accompanying drawings.

R. W. SELDEN,

Agent for the Applicant.

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1481696 COMPLETE SPECIFICATION
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Sheet 1

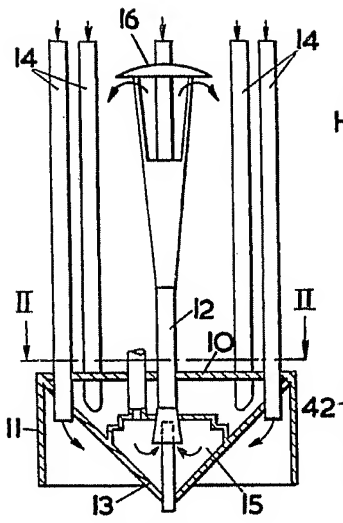

FIG.1.

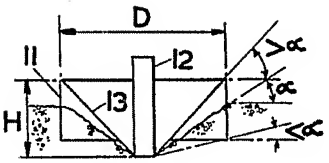

FIG. 3.

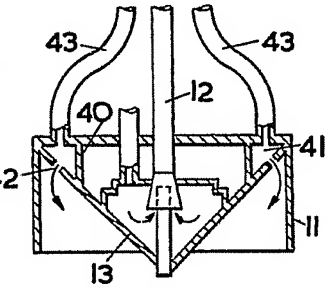

FIG. 4.

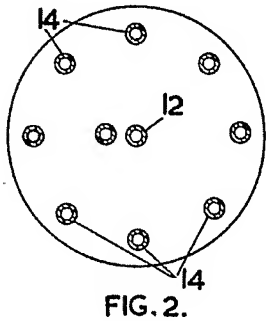

FIG. 2.

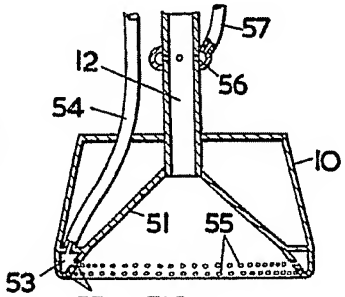

FIG. 5.

1481696 COMPLETE SPECIFICATION
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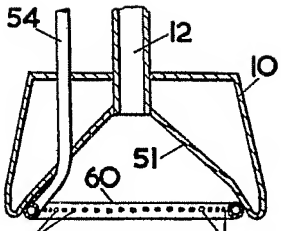

FIG. 6.

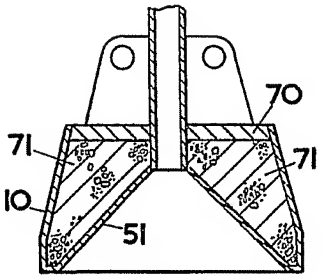

FIG. 7.

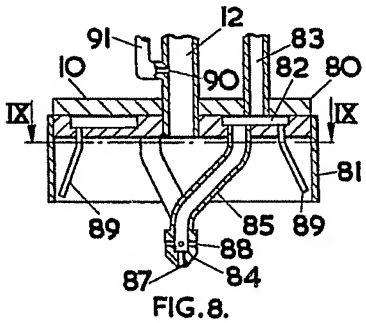

FIG.8.

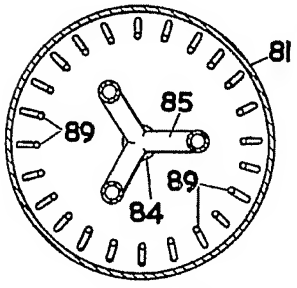

FIG. 9.

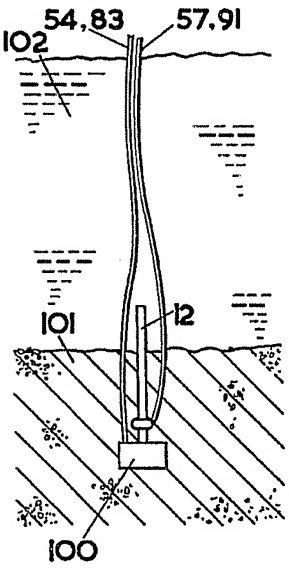

FIG. 10.